Progress Report for
D.O.E. Nuclear Engineering Education Research Program

Grant No. DE-FG07-99ID13765

POINTWISE ENERGY SOLUTION OF THE BOLTZMANN TRANSPORT EQUATION FOR THERMAL NEUTRONS

SUMMARY

In July of 1999 Louisiana State University (LSU) was awarded a two year research grant by the D.O.E. NEER program to develop a methodology for neutron transport calculations using pointwise (PW) nuclear data in the thermal energy range, and to implement the method into the CENTRM transport code being developed at LSU for Oak Ridge National Laboratory (ORNL). This work will extend CENTRM=s current epithermal PW calculation to encompass the thermal range, providing a continuous-energy deterministic transport code that can address problems that may not be adequately treated using multigroup methods. The new code will be applied to computation of eigenvalues and reactivity coefficients for pincell geometries corresponding to high burnup LWR and MOX fuel pins; and results compared to other methods, including pointwise Monte Carlo calculations.

RESULTS OF FIRST YEAR WORK

During the first funding period of July 1, 1999 through June 30, 2000, the grant has provided support for one Masters level student in nuclear engineering (Mr. Rakesh Nair) and a post graduate research associate in nuclear engineering (Mr. Ryanto Raharjo). The project will serve as the thesis research for Mr. Nair.

Table1 shows project milestones for the two year period of support. All milestones listed for

the first year of effort have been completed or are anticipated to be completed by the end of June 2000. Specifically, we have developed the numerical method to be used in CENTRM for calculating the thermal scattering source. Unlike the CENTRM epithermal calculation, the thermal calculation will not use a Asubmoment≅ expansion to evaluate Legndre moments of the scattering integral, but rather a point-to-point scatter matrix based on the problem-specific energy mesh in the thermal range. FORTRAN routines to compute elements of the PW scatter matrix for a free-gas kernel and for the finite-difference form of the heavy gas operator have been written and tested. Legendre moments of an arbitrary expansion order are computed for the free gas kernal, while only P0 moment are calculated for the heavy gas operator. An option is provided allowing a user to specify the mass number above which the heavy gas approximation is to be used. The CENTRM outer iteration algorithm has been extensively modified so that an initial number of multigroup iterations can be performed to provide a starting flux spectrum for the PW thermal calculations. Routines have also been developed to couple the PW epithermal calculation to the PW thermal calculation. The actual computation of the PW thermal flux is currently being implemented in CENTRM. The necessary new routines have been developed and modifications to existing subroutines have been made. We are now in the debug phase.

SCHEDULE

The project is currently on schedule and in budget. No deliverables are specified in the program plan for the first funding period ending June 30, 2000. The second and last year of support for this DOE-NEER project covers the period July 1, 2000 through June 30, 2001, at the level of $76,361. We anticipate beginning the work to treat bound scattering kernels during the summer of 2000, and by the fall of 2000 we would like to begin the verification and application milestones described in table 1.

Table 1.
Milestones for NEER Project

First Year Milestones

1. Develop required numerical expressions for PW scatter source moments;
2. Modify current PW calculation to perform outer iterations in thermal range
3. Implement PW thermal calculation for free-gas materials and Heavy Gas Model

Second year Milestones

4. Implement PW thermal scatter for bound inelastic incoherent, $S(\alpha,\beta)$ data
5. Verifiy PW thermal calculations by comparison with MCNP results
6. Perform benchmark calculations for LWR and MOX fuel pins